Pediatric Resident Education in Pediatric Cardiology – A Needs Assessment

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Abstract

Background: Although congenital heart disease is the most common human birth defect, the scope and breadth of pediatric cardiology is far more diverse. Additionally, there continues to be rapid advancements in the field with educators becoming increasingly sub-specialized. As such, determining the topics general pediatric residents are taught must be selected based on numerous factors including resident career goals, core topics for board exams, and educator preferences. This study aimed to determine if the educational needs of general pediatric residents are met while on a pediatric cardiology rotation.

Methods: All PL-2 and PL-3 residents in the Children's National Hospital pediatrics residency program who had completed a required cardiology rotation as well as all pediatric cardiology fellows and pediatric cardiology attendings were asked to complete a survey. Participation in the study was voluntary. Respondents were asked to answer questions related to the perceived effectiveness and applicability of the currently administered cardiology curriculum, specifically inquiring about methods of teaching, the level taught, and the utility of topics selected.

Results: Twenty-four (31%) of the 77 eligible residents completed the survey. Fourteen (82%) of the eligible attendings and nine (75%) of the cardiology fellows completed the survey. Seventeen unique topics in pediatric cardiology were ranked. The highest rated topics based on both perceived needs and wants included congenital heart disease, murmurs, cardiac physiology, ECG interpretation, and syncope/dizziness. Participants reported the highest satisfaction for whiteboard and bedside teaching.

Conclusions: Overall, general pediatrics residents were satisfied with the current educational design of the inpatient cardiology rotation. These data provide a framework, both in teaching modalities and core concepts, for continued development and reassessment of inpatient pediatric cardiology rotations to optimally prepare pediatric residents with a strong foundation in pediatric cardiology.

Background

Congenital heart disease (CHD) is the most common human birth defect, with an estimated incidence of 1.8 cases per 100 live births [1]. However, the field of pediatric cardiology goes well beyond CHD and includes murmurs, chest pain, syncope, arrhythmias, and infectious and noninfectious acquired cardiovascular diseases. As pediatric residents graduate from programs, they will undoubtedly provide care to children with confirmed or suspected congenital and acquired heart disease. While educational goals may differ for residents who intend to pursue primary care pediatrics versus those who intend to pursue one of the various pediatric subspecialties, a systematic and organized approach is needed to appropriately educate general pediatric residents on all aspects of pediatric cardiology. Therefore, it is imperative that the three years of general pediatrics residency provide a sound foundation built on the core concepts of pediatric cardiology as specified by the American Board of Pediatrics [2].

However, due to significant growth in knowledge, technologies, and procedures over the past 80 years, pediatric cardiology topics have become more specialized, resulting in niche content areas affecting the curriculum of residents on pediatric cardiology rotations. Large pediatric residency programs with robust pediatric cardiology departments are decreasing required rotations in the cardiac intensive care unit [3]. This leads to decreased exposure of pre- and post-operative cardiac care as well as general inpatient cardiology care, ultimately eliminating the practical, case-based education from daily work rounds. Furthermore, educators in pediatric cardiology at large academic centers are often subspecialists which can lead to educational subject biases, the potential underrepresentation of core concepts of pediatric cardiology, and teaching at an inappropriate level for residents.

To our knowledge, there is no published data investigating if the educational needs of general pediatric residents are adequately addressed while on a pediatric cardiology rotation. In determining the appropriate experience, goals from both educators and learners must be considered [4]. This study used a questionnaire-based assessment from both pediatric residents and attendings/fellows on a pediatric inpatient cardiology experience at a single institution. The primary aim was to determine if the educational needs of general pediatric residents are met while on a pediatric cardiology rotation. Secondary aims studied the preferred teaching modalities and core topics to be covered.

Methods

Study Population

All second- and third-year general pediatrics residents that had previously rotated on the required pediatric cardiology rotation as well as all pediatric cardiology fellows and pediatric cardiology attendings with direct inpatient contact were surveyed. This study was approved by the Institutional Review Board at Children's National Hospital (CNH) in Washington, DC (IRB#13876). At the time of study, there were 37 pediatric level third year residents (PL-3s) and 40 second year pediatric level residents (PL-2s) at CNH. Each PL-2 is scheduled to complete a two-week block on the inpatient cardiology ward (Heart and Kidney Unit - HKU) and a portion of the PL-2 cohort will also complete two weeks of night float on the HKU. PL-3s can opt to fulfil a portion of their required night float on the HKU, however this is not a requirement. On average, residents have 3-4 educational sessions prior to morning rounds per week. These sessions include scheduled lectures by attendings/fellows, self-directed online modules, resident presentations, and a monthly arrhythmia skills simulation. CNH has 12 cardiology fellows who rotate through the HKU between 3-5 weeks per year depending on PL year of training (PL-4 to PL-6). Finally, there are 17 attendings that spend on average 3 weeks per year as the primary inpatient cardiology attending on the HKU.

The survey asked residents, fellows, and attendings to identify their level of training, likely career path, and whether they believed an update to the current cardiology curriculum was needed. The respondents were also asked to answer questions related to the perceived effectiveness and applicability of the currently designed cardiology curriculum specifically inquiring about methods of teaching, level taught,

and utility of topics selected. Further, they were asked to rank the usefulness of 17 unique topics in pediatric cardiology. Participation in the study was voluntary. Survey responses were anonymous and identified only by study numbers. (Appendix 1,2)

For data analysis, a combination of regression analyses and descriptive statistics was utilized as appropriate. Likert scale responses were translated into ordinal numbers (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree) and a mean score and standard deviation (SD) were calculated to stratify categories and provide descriptive comparisons. The correlation between the average rank given for each topic between the residents and attendings/fellows was calculated using a Spearman correlation.

Results

Twenty-four (31%) of the 77 eligible residents completed the survey. Response rates according to PL year were 28% for PL-2 and 35% for PL-3. Most residents identified their likely career path to be cardiology (29%), followed by general pediatrics (21%), emergency medicine (17%), and hospitalist medicine (13%). Other career paths identified were neonatology (4%), critical care (4%), and rheumatology (4%). Fourteen (82%) of the eligible attendings and nine (75%) of the cardiology fellows completed the survey. The attending subspecialty within pediatric cardiology was most frequently advanced imaging (43%), followed by general cardiology (29%), electrophysiology (14%), adult congenital heart disease (7%), and cardiac intensive care (7%).

Fourteen (61%) of the participating residents responded that an update is needed regarding how pediatric cardiology is taught during their inpatient cardiology rotation compared to nine (39%) residents who responded no change is needed. With respect to the residents that responded an update is needed, 71% indicated they planned to pursue a career in acute care (cardiology, emergency medicine, hospitalist, neonatology, critical care). Twenty (87%) of the attendings and fellows responded an update in the educational experience is needed. Attending/fellows were 4.29 times more likely to respond that an update is needed compared to residents ($p = 0.053$). Most residents (75%) as well as the attendings/fellows (87%) responded that the educational needs based on the residents' individual career goal were either "sometimes incorporated" or "often incorporated" into the cardiology educational program.

Table 1 shows results from three survey questions. The two groups responded significantly different to the question whether the educational goals in pediatric cardiology are met by the current educational design ($p=0.002$). In general, attending/fellows are less likely to respond positively than residents ($OR=0.107$). The predicted probability of a resident responding "disagree" is only 4%, while the same response is predicted to be 26% from an attending/fellow. Similarly, the two groups responded significantly different regarding the effectiveness of the current model of teaching ($p=0.024$). In general, attending/fellows are less likely to respond positively than residents $OR=0.152$ with 22% of residents and only 4% of attending/fellows predicted to "strongly agree". When questioned whether the level of the

current curriculum is appropriate, there is no evidence that the two groups responded differently ($p=0.30$). Most of the residents (89%) as well as attendings/fellows (81%) agreed or strongly agreed that the current curriculum is taught at an appropriate level.

Table 1

Results of three survey questions from pediatric residents and cardiology attending/fellows regarding educational goals, effectiveness of teaching and level of current curriculum on the inpatient cardiology rotation.

Group	Response				OR	p-value	95% CI
	Disagree	Neither agree nor disagree	Agree	Strongly agree			
Educational goals in pediatric cardiology are met by the current curriculum							
Resident	2	1	17	4	1.00		
Attending/Fellow	5	8	10	0	0.107	0.002	0.026 – 0.445
Predicted probabilities							
Resident	0.04	0.08	0.73	0.15			
Attending/Fellow	0.26	0.29	0.43	0.02			
The current model of teaching pediatric cardiology on the cardiology rotation is effective							
Resident	1	1	16	6	1.00		
Attending/Fellow	0	5	18	0	0.152	0.024	0.030 – 0.785
Predicted probabilities							
Resident	0.006	0.04	0.74	0.22			
Attending/Fellow	0.04	0.21	0.72	0.04			
The level at which the current curriculum taught is appropriate							
Resident	0	3	15	6	1.00		
Attending/Fellow	1	3	16	3	0.529	0.30	0.158 – 1.771
Predicted probabilities							
Resident	0.02	0.10	0.65	0.24			
Attending/Fellow	0.03	0.16	0.67	0.14			

Participants were then asked to rate 17 commonly taught topics in pediatric cardiology using a Likert scale with 1 (low value) and 5 (high value). First, survey participants were asked to rate the value of each topic based on what the residents “need to know” to successfully answer the cardiology questions on the pediatrics board exam. Second, survey participants were asked to rate the value of each topic based on what the residents “want to know” with respect to future career goals. The responses are depicted as mean value, rank by group, as well as overall importance (Tables 2 and 3).

In Table 2, responses show the residents ranked CHD, ECG interpretation, and murmurs as the top 3 topics they need to know, whereas the attending/fellow group ranked CHD, murmurs, and syncope/dizziness as the top 3 topics the residents need to know. After averaging the two groups’ rank, the top 3 topics residents need to know are CHD, murmurs, syncope/dizziness, and cardiac physiology (last two tied). ECG interpretation demonstrated the greatest difference among ranks with the residents ranking it #2 and the attending/fellows ranking it #8. Overall, the r value for the “need to know” topics is 0.868 ($r^2=0.753$) with a p value <0.001 . There is a significant correlation between the ranks given by each group, such that the topics rated as important by residents were also rated as important by attending/fellows.

Table 2
Comparing need to know topics between residents and attending/fellows

Topic	Residents	Attending/ Fellow	Average rank of importance for both groups
	Mean (Rank)	Mean (Rank)	
Congenital heart disease	4.70 (1)	4.22 (1)	1
Murmurs	4.52 (3)	4.17 (2)	2
Syncope/Dizziness	4.22 (5)	4.13 (3)	3
Cardiac physiology	4.39 (4)	4.09 (4)	3
Kawasaki disease	4.39 (4)	3.96 (6)	4
ECG interpretation	4.65 (2)	3.83 (8)	4
Chest pain	4.22 (5)	4.00 (5)	4
Cardiac emergencies	4.39 (4)	3.78 (9)	5
Cardiac involvement associated with syndromes	3.65 (8)	3.91 (7)	6
Arrhythmias	4.17 (6)	3.65 (10)	7
Endocarditis	3.83 (7)	2.65 (11)	8
Intercurrent illnesses with congenital heart disease	3.22 (9)	2.30 (12)	9
Antiarrhythmic medications	3.22 (9)	2.09 (13)	10
Pulmonary hypertension	3.22 (9)	1.91 (15)	11
Single ventricle palliation	2.74 (10)	1.96 (14)	12
Care of postoperative cardiac patients	2.35 (11)	1.57 (17)	13
Pacemakers	2.70 (12)	1.43 (17)	14
Correlation between ranks	r=0.868	P<0.001	

In Table 3, responses show residents rated murmurs, cardiac physiology, ECG interpretation, cardiac emergencies, and CHD (last two tied) as the top 3 topics they wanted to know. The attending/fellow group rated CHD, cardiac physiology, and ECG interpretation as the top 3 topics the residents want to know. After averaging the two groups' ranks, the top 3 topics for "want to know" were CHD, cardiac physiology, ECG interpretation, cardiac emergencies, and murmurs (last two tied). The topic of murmurs had the greatest difference in rank among the top ten ranked topics with the residents ranking it #1 and the attending/ fellow group ranking it #6. Overall, the r value for the want to know topics is 0.750

($r^2=0.562$, $p < 0.001$). Thus, similar to the “need to know” topics, there is a significant correlation between the ranks for the “want to know” topics between groups.

Table 3
Comparing want to know topics between residents and attending/fellows

Topic	Residents	Attending/ Fellow	Average rank of importance for both groups
	Mean (Rank)	Mean (Rank)	
Cardiac physiology	4.35 (2)	4.61 (2)	1
Congenital heart disease	4.22 (3)	4.69 (1)	1
ECG interpretation	4.35 (2)	4.35 (3)	2
Cardiac emergencies	4.35 (2)	4.18 (5)	3
Murmurs	4.61 (1)	4.04 (6)	3
Arrhythmias	4.00 (7)	4.22 (4)	4
Syncope/Dizziness	4.17 (4)	3.56 (8)	5
Chest pain	4.13 (5)	3.56 (8)	6
Kawasaki disease	4.04 (6)	3.04 (9)	7
Endocarditis	3.70 (10)	2.91 (10)	8
Intercurrent illnesses with congenital heart disease	3.74 (9)	2.87 (11)	8
Cardiac involvement associated with syndromes	3.91 (8)	2.78 (12)	8
Single ventricle palliation	2.91 (14)	3.73 (7)	9
Pacemakers	3.00 (13)	2.78 (12)	10
Pulmonary hypertension	3.26 (11)	2.70 (14)	10
Antiarrhythmic medications	3.22 (12)	2.48 (15)	11
Care of postoperative cardiac patients	2.78 (15)	2.73 (13)	12
Correlation between ranks	r=0.750	P<0.001	

Consistently CHD, murmurs, cardiac physiology, ECG interpretation, and syncope/dizziness were topics ranked in the top three for both groups as well as both categories of “need and want to know”. When comparing the rank of importance for both groups for “need to know” and “want to know”, the top 12 topics were identical. Thus, the same 5 topics consistently ranked the least valuable for both “want and

need to know” by both groups, including antiarrhythmic medications, pulmonary hypertension, single ventricle palliation, care of postoperative cardiac patients, and pacemakers.

The two groups were asked to rank the effectiveness of 5 common teaching methods and then residents alone were asked to rank the frequency at which the methods are implemented (Figures 1 and 2). Likert responses were utilized (1=least effective/least frequent, 5=most effective/most frequent). Figure 1 shows that both groups favored chalk talks/white board talks and bedside teaching in effectiveness. For the resident group, chalk talks/white board talks were felt to be most effective with mean of 4.3 ± 1.0 closely followed by bedside teaching with a mean of 4.2 ± 1.0 . The remaining three modalities were less favored including PowerPoint presentations, online modules, and presentations prepared by co-residents, with means ranging from 1.9-2.6. For the attending/fellow group, bedside teaching was felt to be most effective with mean of 4.3 ± 0.9 closely followed by chalk talks/white board talks a mean of 4.2 ± 0.9 . The remaining three modalities were also less favored with means ranging from 1.6-2.5. (Figure 1)

Figure 2 shows that residents responded both chalk talks/white board talks and bedside teaching were the most utilized with chalk talks/white board talks having a mean of 4.3 ± 1.3 followed by bedside teaching with mean of 3.7 ± 1.2 . The three less utilized modalities had means ranging from 1.9-3. (Figure 2)

Discussion

This questionnaire-based needs assessment study highlights several important aspects about the pediatric cardiology education for pediatric residents at a single institution. First, it demonstrates a strong correlation between what residents and attendings/fellows perceive should be the topics taught to residents to prepare them for both the pediatric boards as well as their intended future career goals. Second, it demonstrates that white board talks and bedside teaching are the preferred methods of teaching during an inpatient cardiology rotation. Finally, it shows that the residents are overall quite satisfied with the current pediatric cardiology educational experience in contrast to how the attendings/fellows perceive the current state. These results support the current inpatient education structure and provide a model for educational design at other institutions.

The ABP provides a content outline of topics that may be covered by the pediatric board exam, with cardiology accounting for approximately 4%. Topics include abnormal blood pressure, chest pain, syncope, congenital heart disease, dysrhythmias, cardiomyopathies, infection/vasculitis, connective tissue disease, and dyslipidemias [1]. According to the ABP, in 2018, approximately 40% of pediatric residents chose to subspecialize [5]. In our cohort, 79% of surveyed residents planned to continue onto a pediatric subspecialty. Our cohort closely mirrored Children's National Hospital's (CNH) average percentage of individuals who choose to specialize, suggesting this discrepancy is most likely related to

an overall higher percentage of residents at CNH who choose to subspecialize. While pediatric subspecialties vary widely, most individuals in the pediatric field will encounter patients with cardiovascular disease. Therefore, tailoring a portion of their cardiology education to provide a solid foundation for fellowship and beyond is vital. For that reason, our needs assessment inquired about what topics residents felt they need to know for the pediatric boards as well as want to know for their future careers.

At CNH, residents spend on average 2-3 weeks total rounding with the inpatient acute care cardiology service. Given this limited time, it is vital to optimize both the teaching modalities and the topics selected. In general, there is a strong correlation between what topics the residents and attendings/fellows want to be taught. The concordance between residents and attendings/fellows in ranking topics in both categories of "need and want to know" provide a repository for which topics should be selected when teaching pediatric cardiology in an inpatient setting. Notably, when combining both residents and attendings/fellow groups, the same 12 topics were consistently selected for both "need to know" and "want to know", suggesting these 12 topics be incorporated in the educational design in some manner. The authors suggest that, given the limited time on the cardiology floor, creating a tailored educational schedule to the specific cohort of rotating residents may be beneficial.

In topics that are perceived to be challenging or poorly understood, such as pediatric cardiology, utilizing strategies to motivate the learners is essential. Central to understanding motivation in learning are two important concepts, the value of a goal and the expectation for successful attainment of that goal. Learners are motivated to engage in behaviors that attain goals with high relative value, such as the resident's two main educational goals of obtaining a solid knowledge base for future career goals and passing the pediatric boards [6]. This is an example of instrumental value which represents the degree at which an activity helps one accomplish other important goals, such as gaining the extrinsic reward of passing the boards [7]. Additionally, the learner must feel as though they can successfully achieve the goal. This is termed expectancy. There are many strategies that target both the values and expectancies of goals. One such strategy is to provide flexibility and control in what students are taught, which allows them to make choices that are in line with their goals. Ambrose et al. describes one way to give students greater flexibility is to allow them to choose portions of the course content. This strategy provides a sense of control, which can contribute to a student's expectation of success. (6)

Based on the study responses and the strategy above, the authors propose developing two sets of topics. The first series is "core concepts" and the second series is "preferred concepts." The "core concepts" would focus on the most highly ranked topics including CHD, murmurs, cardiac physiology, ECG interpretation, and syncope/dizziness. Based on resident responses, the optimal delivery would be a prescheduled morning white board talk followed by the specific topic being incorporated and highlighted into the bedside teaching that same day. For the second series, the rotating resident cohort would vote on additional topics from the 12-topic list that would provide a tailored approach to the cardiology topics taught based on the resident interests and future goals.

Interestingly, attendings/fellows reported lower satisfaction with the current curriculum than the residents. While there was no one clear reason for this difference, there were a few themes that were reported by the attendings/fellows (teachers). The first was a concern for lack of involvement of the residents (learners). Since the current model has only 3 residents at one time, the group is small and the absence of one learner can have a significant impact on the teacher's perceptions. Some attendings were asked to provide lectures outside of their specific subspecialty and this perhaps reducing teacher satisfaction and perceived effectiveness. Lastly, attendings/fellows may have ranked their satisfaction more based on scheduled lectures rather than incorporating spontaneous bedside teaching and non-scheduled white board discussion throughout the day.

There are several limitations to the study. This study was a single center study with limited number of participants. As previously mentioned, the study was limited to PL-2 and PL-3 residents who had completed a rotation on the acute care cardiology service. Additionally, the study may be subject to survey sampling bias. Although there was less than a 50% response rate, the percent of respondents planning on subspecializing was similar to CNH's resident average. Therefore, we feel respondents accurately represented residents at CNH although we do not have demographic data to differentiate respondents from non-respondents. More importantly, residents at CNH may not be representative of all pediatric residents.

In conclusion, this is the first needs assessment of an inpatient cardiology education program at a large pediatric residency program with a pediatric cardiology program of over 500 surgical cases per year. The results suggest tools for an optimal educational design for an inpatient pediatric cardiology educational experience. The top rated "core topics" for resident education include CHD, murmurs, cardiac physiology, ECG interpretation, and syncope/dizziness. The teaching modalities with the highest satisfaction are whiteboard and bedside teaching. To provide a tailored experience and improve motivation, additional topics can be selected by each pediatric cohort to include relevant cardiac aspects of various pediatric careers. These results provide a framework for continued development and reassessment of inpatient pediatric cardiology curricula to best develop general and subspecialist pediatricians.

Abbreviations

ABP
American Board of Pediatrics
CHD
Congenital Heart disease
CNH
Children's National Hospital
HKU
Heart and Kidney Unit
PL-2
Pediatric level second year

Declarations

Ethics approval and consent to participate

This research was reviewed and approved by Children's National Hospital Institutional Review Board (IRB#13876).

Written informed consent to participate in the research was obtained from all participants. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

Additional data and materials can be made available upon request to the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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There was no funding for the study.

Authors' contributions

IWH designed, analyzed the data, and wrote the manuscript. LF contributed to study questionnaire designs. HGD analyzed and interpreted the data and performed statistical analysis. CS facilitated in writing the manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

Effectiveness of learning methods

Figure 2

Frequency of learning methods

Supplementary Files

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- [SupplementalMaterial.docx](#)
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